

## PATENT COOPERATION TREATY

## PCT

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# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 800213WO	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/FI 03/00602	International filing date (day/month/year) 12.08.2003	Priority date (day/month/year) 15.08.2002
International Patent Classification (IPC) or both national classification and IPC H01L31/115		
Applicant DETECTION TECHNOLOGY OY et al.		

- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 6 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
 These annexes consist of a total of 4 sheets.

- This report contains indications relating to the following items:
  - I ☒ Basis of the opinion
  - II ☐ Priority
  - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
  - IV ☐ Lack of unity of invention
  - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
  - VI ☐ Certain documents cited
  - VII ☐ Certain defects in the international application
  - VIII ☐ Certain observations on the international application

Date of submission of the demand  11.02.2004	Date of completion of this report  03.11.2004
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Kusztelan, L  Telephone No. +49 89 2399-2479  

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. **PCT/FI 03/00602**

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*):

**Description, Pages**

1-22 as published

**Claims, Numbers**

34-51 as published

1-33 received on 27.09.2004 with letter of 27.09.2004

**Drawings, Sheets**

1/13-13/13 as published

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability**

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application,

☒ claims Nos. 2,11,12,14-19,24-26

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (specify):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

**see separate sheet**

☒ the claims, or said claims Nos. 2,11,12,14-19,24-26 are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos.

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the Standard.

☐ the computer readable form has not been furnished or does not comply with the Standard.

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims	1,3,13,20-23,27-33
	No: Claims	
Inventive step (IS)	Yes: Claims	1,3,13,20-23,27-33
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-33
	No: Claims	

2. Citations and explanations

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**see separate sheet**

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Section II

Having regard to the subject-matter of amended claims 1 & 20, support for the dependent claims 2,11,12,14-19,24-26 could not be located. These claims are thus not examined further.

Section V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

- D1: US-A-5371351
- D2: US-A-6 002 134 (LINGREN CLINTON L) 14 December 1999
- D3: US 2002/017612 A1 (YU GANG ET AL) 14 February 2002
- D4: US-A-4 826 777 (ONDRIS MIROSLAV) 2 May 1989 (1989-05-02)
- D5: US-B1-6 369 853 (MERRILL RICHARD B ET AL) 9 April 2002
- D6: US-A-5 352 884 (GRANFORS PAUL R ET AL) 4 October 1994

(\*) D1 has not been cited in the ISR.

D1 discloses a two dimensional array in which separated device anodes of given columns are electrically connected and separated device cathodes of given rows are electrically connected. The device as claimed in claim 1 differs in that the anodes are interconnected with a electrical interconnection at each cathode is provided for O/P readout.

D4 discloses a one dimensional array with separated photodiodes having electrically interconnected anodes & cathodes serially connected by means of diodes. The device as claimed in claim 1 differs in that an electrical interconnection at each cathode is provided for O/P readout.

D2,D3,D5 & D6 disclose photodiode arrays in a common substrate. The device as claimed in claim 1 differs in that an electrical interconnection at each cathode is provided for O/P readout.

The subject-matter of claim 1 is therefore new. Since there is no pointer to the skilled

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person to consider separate outputs for each cathode of the two dimensional array an inventive step is recognised. Similar remarks apply to claim 20.

CLAIMS

1. An array of photodiodes comprising: a plurality of anodes formed at a first surface of at least one substrate; a corresponding plurality of cathodes formed at a second surface of at least one substrate; and an electrical interconnection  
5 between the plurality of anodes, whereby outputs of the array are provided by the plurality of cathodes.
2. An array according to claim 1 wherein the plurality of anodes and the plurality of cathodes are formed at the first and second surfaces of a corresponding plurality of substrates.
- 10 3. An array according to claim 2 wherein the plurality of substrates are formed by dividing a single substrate.
4. An array according to any one of claims 1 to 3 wherein the plurality of cathodes comprise a plurality of conductive layers formed at the surface of the substrate.
- 15 5. An array according to claim 4, wherein there is further provided a metal layer on each conductive layer.
6. An array according to any one of claims 1 to 5 wherein the plurality of anodes comprise a plurality of active regions formed at the first surface.
7. An array according to claim 6 wherein there is further provided a metal contact  
20 for each active region.
8. An array according to any one of claims 1 to 7 wherein the electrical interconnection is provided by wire bonding.
9. An array according to any one of claims 1 to 7 wherein the electrical interconnection is provided by metal contacts.
- 25 10. An array according to any one of claims 1 to 7 wherein the electrical interconnection is provided by a conductive sheet.
11. An array according to any one of claims 1 to 10 wherein there is further provided a connector interface, the connector interface being provided with a plurality of contacts for contacting the plurality of cathodes.

12. An array according to claim 11 wherein the at least one substrate is formed on the connector interface.
13. An array according to claim 11 or claim 12 wherein the plurality of contacts are connected to the plurality of cathodes by an epoxy.
- 5 14. An imaging system including an array according to any one of claims 1 to 13.
15. A CT imaging system including an array according to any one of claims 1 to 13.
- 10 16. A photo-detector array including a plurality of sub-arrays of photo-detectors, the photo-detectors of each sub-array being formed of: a plurality of anodes formed at a first surface of at least one substrate; a corresponding plurality of cathodes formed at a second surface of at least one substrate; and an electrical interconnection between the plurality of anodes, whereby outputs of the array are provided by the plurality of cathodes, wherein a plurality of said sub-arrays of photo-detectors are placed adjacent to each other in a matrix to form the photo-detector array.
- 15 17. A photo-detector according to claim 16 wherein the matrix extends in two directions.
18. An imaging system comprising: a radiation detector including a photo detector array according to claim 16 or claim 17, a radiation source facing the radiation detector, and means for controlling the radiation detector and the radiation source.
- 20 19. An imaging system according to claim 18 wherein the radiation source is an X-ray tube equipped with a high-voltage generator.
20. An imaging system according to claim 18 or claim 19 wherein the radiation detector and the radiation source are radially mounted in a cylindrical scanning structure.
- 25 21. An imaging system according to any one of claims 18 to 20 wherein the means for controlling comprises a computer system.
22. A method of forming an array of photodiodes, comprising: forming a plurality of anodes at a first surface of at least one substrate; forming a corresponding
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ART 34 AMDT

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- plurality of cathodes at a second surface of the at least one substrate; and electrically interconnecting the plurality of anodes such that the plurality of cathodes provide the outputs of the array.
23. A method according to claim 22 wherein the step of forming a plurality of cathodes comprises providing a plurality of conductive layers on the second surface of the at least one substrate.
24. A method according to claim 23 wherein the plurality of anodes and the plurality of cathodes are formed from a single substrate.
25. A method according to claim 24 wherein the plurality of conductive layers are formed by providing a continuous conductive layer on the second surface of the substrate, and electrically isolating portions of the continuous layer to form the plurality of conductive layers.
26. A method according to claim 25 wherein the portions of the conductive layer are electrically isolated by etching or cutting the continuous conductive layer.
27. A method according to claim 26 wherein the step of etching or cutting further etches the substrate.
28. A method according to claim 27 wherein the substrate is etched or cut completely.
29. A method according to claim 28 wherein there is thus formed a plurality of isolated substrate portions.
30. A method according to any one of claims 26 to 29 wherein the etch or cut is patterned such that a contiguous area is etched or cut around each cathode.
31. A method according to claim 22 wherein the plurality of anodes and the plurality of cathodes are formed from a respective plurality of substrates.
32. A method according to any one of claims 22 to 31 wherein the step of interconnecting the plurality of anodes includes forming wire bonding between anodes on the first surface of the substrate.
33. A method according to any one of claims 22 to 31 wherein the step of interconnecting the plurality of anodes includes providing a metal interconnect between anodes on the first surface of the substrate.

- 34.A method according to any one of claims 22 to 31 wherein the step of interconnecting the plurality of anodes includes providing a conductive sheet over the first surface.
- 5 35.A method according to any one of claims 22 to 34 further comprising the step of connecting the plurality of cathodes to a connector interface.
- 36.A method according to claim 35 wherein the connector interface includes a plurality of pads for connection to the plurality of cathodes.
- 37.A method according to claim 35 wherein the connector interface comprises a substrate.
- 10 38.A method according to claim 35, wherein the connector interface comprises an integrated circuit.
- 39.A semiconductor structure comprising an array of photo-diodes each having an anode and a cathode, in which the anodes are electrically connected and the cathodes are electrically isolated.
- 15 40.A semiconductor array according to claim 39 wherein the anodes are formed on one surface of a substrate and the cathodes are formed on another surface of the substrate.
- 41.A semiconductor device according to claim 39 wherein the cathodes are electrically isolated by openings through the semiconductor structure.
- 20 42.A semiconductor device according to claim 41 wherein an opening through the semiconductor device surrounds each anode.
- 43.A semiconductor device according to any one of claims 39 to 42 wherein the anodes are electrically connected by wire bonding.
- 44.A semiconductor device according to any one of claims 39 to 44 wherein the anodes are electrically connected by a sheet of material.
- 25 45.A semiconductor device according to claim 44 wherein the sheet of material is formed over the surface of the device.
- 46.An array of photodiodes, each photodiode comprising a substrate having an active area comprising an anode formed in a first surface thereof and a cathode formed on a second surface thereof, wherein the anodes of the array
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are electrically interconnected, the cathodes providing the outputs of the photodiode array.

47. A method of manufacturing an array of photo-diodes comprising forming a plurality of active areas forming anodes in a first surface of the device and at least one cathode formed on a second surface of the device, the method comprising: electrically connecting the anodes, and electrically isolating the cathodes.
48. A semiconductor packaging structure substantially as described herein with reference to or as shown in any one of Figures 2 to 6.
49. A semiconductor packaging structure substantially as described herein.
50. An imaging system substantially as described herein with reference to or as shown in any one of Figures 2 to 9.
51. An imaging system substantially as described herein.